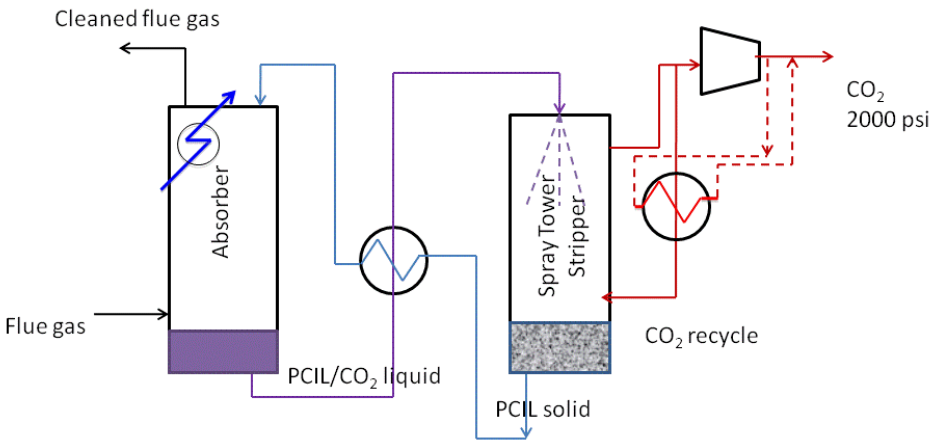
# $CO_2$ Capture with Ionic Liquids Involving Phase Change

Prof. Joan F. Brennecke/ University of Notre Dame

## Technology Summary

A new concept for $CO_2$ capture that uses *phase change ionic liquids (PCILs)* offers the potential to significantly reduce parasitic energy losses incurred from capturing $CO_2$ from flue gas. PCILs are solid ionic materials that have high $CO_2$ uptake (one mole of $CO_2$ for every mole of salt at post-combustion flue gas conditions) and form a liquid when they react with $CO_2$. This allows for a novel process that uses the heat of fusion to provide part of the heat needed to release $CO_2$ from the absorbent, reducing the total energy required. This project will (1) develop and characterize PCILs; (2) evaluate energy savings in a new $CO_2$ capture process; and (3) demonstrate the technology at laboratory scale.




## Key Personnel

ND: Joan F. Brennecke, Edward J. Maginn, Mark J. McCready, Patrick Murphy, William F. Schneider

MATRIC: George Keller

## Program Summary

Period of performance: 36 months

| | Key Milestones & Deliverables |
|---|---|
| Year 1 | • Characterization of first set of PCILs (TRL 3)<br>• Identification of key process variables |
| Year 2 | • Detailed process model based on theoretical and experimental results<br>• Go/NoGo based on predicted parasitic energy |
| Year 3 | • TRL 4 demo of PCIL based $CO_2$ capture process |

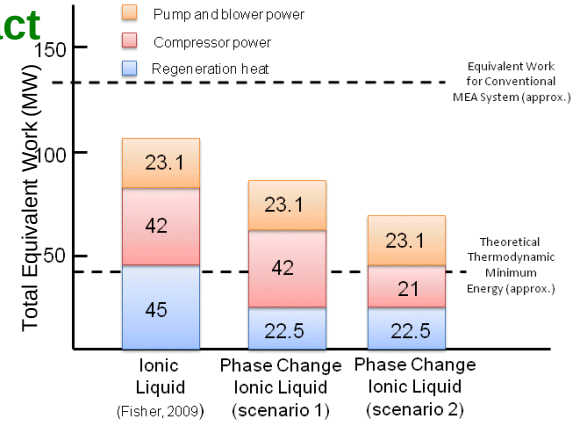
## Technology Impact

In a 500 MW (471 MW de-rated) coal plant:

Aqueous amine scrubbing incurs parasitic energy losses of 28% (132 MW).

Current ILs could reduce energy losses to 23% (110 MW)

**Proposed PCIL process could reduce energy losses to 14% (66 MW)!**




**Radically Reducing the Cost of Carbon Capture**

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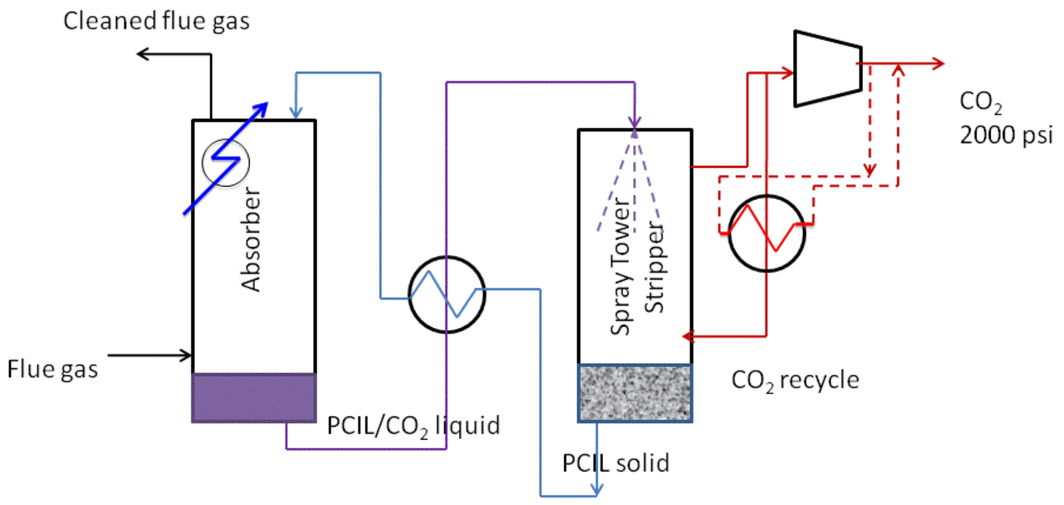
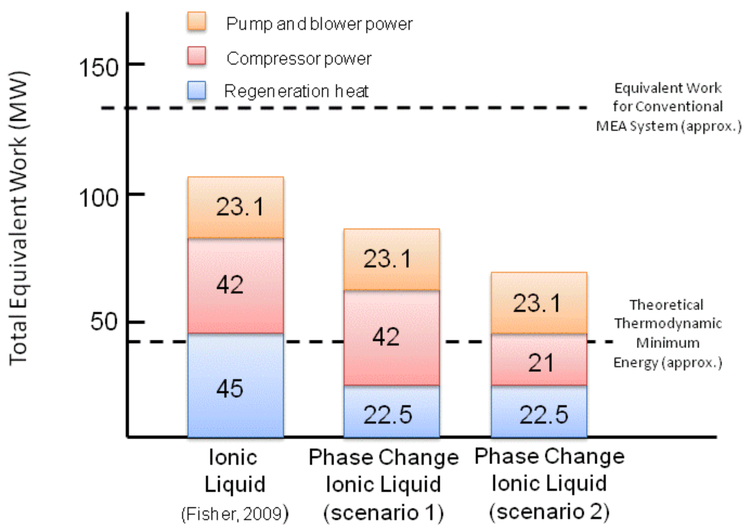



Goal: develop ionic salts that undergo a phase change (from solid to liquid) when they react with $CO_2$; taking advantage of the enthalpy change when PCILs react with $CO_2$ to enable capture of 90% of the $CO_2$ from post-combustion flue gas with less than a 35% increase in the cost of electricity.

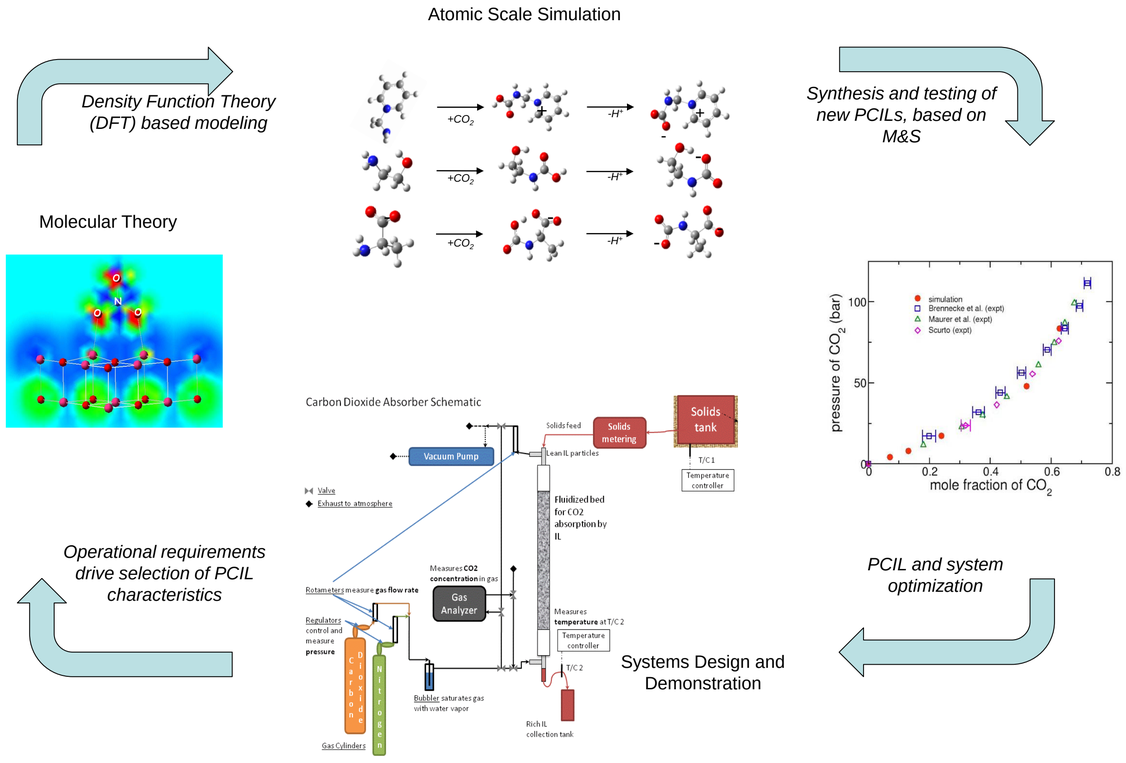
**Discovery** - solid ionic materials that:
- have high $CO_2$ uptake (close to one mole of $CO_2$ per mole of salt at post-combustion flue gas conditions) and
- form a liquid when they react with $CO_2$

**Invention** – use the heat of fusion (generated as the salt solidifies upon release of $CO_2$) as part the heat needed to release the $CO_2$ from the absorbent in the solvent regeneration step




In a 500 MW (471 MW de-rated) coal plant:
- Aqueous amine scrubbing incurs parasitic energy losses of 28% (132 MW).
- Current ionic liquids could reduce this to 23% (110 MW)
- **Proposed PCIL process could reduce energy losses to 14% (66 MW)**

## Approach

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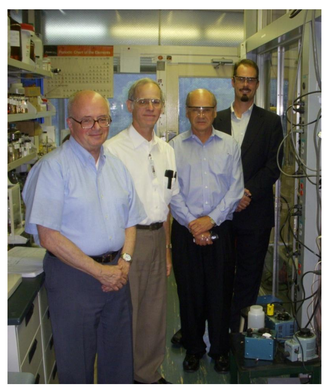
## Progress to Date

- Synthesized five Gen1 PCILs
- Measured $CO_2$ uptake of two Gen1 PCILs and began measurements of other compounds
- Developed forcefields for Gen1 PCILs and initiated molecular simulations
- Initiated measurements of heats of reaction and construction of packed bed absorption column
- Initiated process modeling

**University of Notre Dame Team**



**MATRIC Team**